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(54) PREPARATION OF NUCLEAR FUEL ELEMENTS

(71) We, CANADIAN GENERAL ELECTRIC COMPANY LIMITED, a company organized under the Laws of Canada, of 214 King Street West, Toronto, Ontario, Canada, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is directed to a method of making nuclear fuel elements, and to fuel elements produced by the method.

In the preparation of composite nuclear fuel elements problems are encountered both in the safe physical handling of the materials, and in regulating the dispersion of an added material through the core material. Thus in preparing a mixed oxide nuclear fuel element, for example a mixture of uranium dioxide and plutonium dioxide, the conventional methods of physically mixing the two oxides in the desired predetermined proportions requires the use of multiple glove box operations.

According to the invention, there is provided a method of manufacturing an enriched nuclear fuel element including the steps of forming a fuel member, impregnating the fuel member with a solution of enrichment material, drying the fuel member, and converting the enrichmnet material to the metallic oxide.

By the term "fuel member" used throughout this specification and claims, there is meant a compacted member of the basic fuel ingredient either before or after sintering and grinding thereof. Such fuel members are often in the form of pellets.

The present invention provides a method for making uranium oxide elements or pellets having a controlled dispersion of plutonium dioxide therein, which is achieved by impregnating the uranium dioxide fuel members or pellets with a solution of a plutonium compound such as plutonium nitrate, drying the impregnated pellets and then converting the plutonium compound to plutonium oxide. This provides pellets of mixed uranium and plutonium dioxides having a potentially wide use in reactors of many different types.

The impregnation or enrichment of the basic fuel member or pellet of uranium dioxide may be effected either after the pellet has been sintered, ground to size, washed and dried, or with the pellet in the "green" state, prior to sintering. The particular advantage of impregnating the fuel member or pellet at a later stage, subsequent to sintering, grinding, washing and drying is the simplified handling which is obtained. In the case where the oxide mixture is produced while the fuel member or pellet is in th "green" state, it is necessary for purposes of safety to utilize glove boxes much more extensively, whereas by impregnating the substantially completed basic fuel member pellet the number of glove box controls required may be substantially reduced. However, impregnation of green fuel members or pellets presents considerable advantages over conventional methods.

In either instance the converting of the impregnated pellets to provide a plutonium oxide dispersion may be effected by heating the dried pellet to the required temperature in a suitable environment.

Particular advantages provided by a composite pellet of this type, in which the degree of enrichment may be readily controlled, reside in the preparation of elongated fuel bundles having varied axial plutonium enrichment. In addition, the enrichment of the reactor core may also be controlled radially to provide an optimised flux pattern and uniform fuel burnup. A further advantage of such a fuel utilization system would be a reduction in the fuel shuffling within a reactor of the pressure tube plutonium recycle type.

Another advantage afforded by the present invention is the provision of fuel elements or pellets in which the distribution of enriching material in the pellet may be controlled to provide an improved reactivity effect by appropriate control of the impregnation conditions.

In addition to the manufacture of mixed

[Price 25p]

oxide fuel of uranium dioxide and plutonium dioxide, use of the method according to the invention is also contemplated in the preparation of mixtures of oxides of thorium with plutonium, thorium with uranium enriched in U235, and thorium or natural uranium and U233.

The terms enriching and enrichment as herein employed entail the increasing of the concentration of fissile material.

WHAT WE CLAIM IS:—

1. A method of manufacturing an enriched nuclear fuel element including the steps of forming a fuel member, impregnating the fuel member with a solution of enrichment material, drying the fuel member, and converting the enrichment material to the metallic oxide.

2. The method as claimed in Claim 1, wherein the fuel element comprises uranium oxide and the enrichment matrial is plutonium.

3. The method as claimed in Claim 3, wherein the plutonium is converted from the impregnation state to plutonium oxide, PuO_2.

4. The method as claimed in any one of Claims 1, 2 or 3, wherein the fuel member is sintered and ground prior to the impregnation step.

5. The method as claimed in any one of Claims 1, 2 or 3, wherein the member is in the green state prior to said impregnation step.

6. The method as claimed in Claim 2 wherein the plutonium solution is a solution of plutonium nitrate.

7. A nuclear fuel element bundle comprising a plurality of similar fuel elements produced as claimed in any one of claims 1 to 6, the enrichment of some of the elements being varied.

8. A nuclear fuel element bundle as claimed in Claim 7, wherein the enrichment of each fuel element is initially predetermined in dependence on its position with respect to the other elements.

9. A method of manufacturing an enriched nuclear fuel element substantially as herein described.

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